

Understanding Growth in Europe, 1700-1870: Theory and Evidence

Joel Mokyr
Depts. of Economics and History
Northwestern University
Berglas School of Economics
Tel Aviv University

Hans-Joachim Voth
Department of Economics
Pompeu Fabra University

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Incomes of ordinary citizens in developed countries today dwarf those enjoyed even by the wealthy elite during most of mankind's history. As John Maynard Keynes, with slight incredulity, observed in 1930 – the economic problem of mankind (in Europe and North America at least) has been solved.¹ People no longer go hungry. Clean clothes, shelter, and warmth have gone from luxuries to necessities. By 1870, developments that would eventually deliver this full complement of riches were already in full swing. This article summarizes recent research by growth economists on how mankind escaped from a life that was, in the words of Thomas Hobbes, “nasty, brutish, and short”. It contrasts these interpretations with the existing historical evidence and recent findings of economic historians, focusing on four areas that have been of particular concern – demography, human capital, institutions, and technology. We conclude with suggestions for future research.

1. Theoretical Approaches

In the late 1980s and early 1990s, macroeconomist began to turn their attention from business cycles to the determinants of long-run economic growth. Papers in the endogenous growth paradigm sought to explain why some countries had grown more rapidly than others. The main period of interest to which these models were applied was the post-war era. They returned to Kuznets's classic argument that current growth rates, when extrapolated backward, implied absurdly low incomes in early modern times and before. Therefore, there must have been a long period of stagnation before modern growth started. But what was the source of the phase transition from a world of very low or zero rates of growth to a modern world of rapid and sustained growth?

From the 1990s onwards, scholars began to aim for an overarching theory that could encompass both slow growth and the transition to rapidly increasing per capita incomes – a “unified growth model”. The field has been vibrant in recent years. A number of themes stand out – demography, the role of technology, human capital and culture, and the influence of institutions. We first summarize some of the most prominent contributions in the theoretical literature. In the main part of the paper, we confront the predictions of theorists with the main facts unearthed by economic historians. Our conclusion offers some suggestions on how progress can be made.

Early models in what has since become known as unified growth theory, such as Kremer's (1993) paper, modeled the transition as one long, gradual, acceleration of growth rates. As in some other papers in the endogenous growth literature, Kremer's model assumes that more people spell faster technological change since the probability of a person having a bright idea is more or less constant. Since ideas are non-rivalrous, growth accelerates. Kremer showed that some of the basic predictions derived from such a simple growth model driven by population size hold both over time and in cross-sections. Since one million BC, growth rates of population can be predicted from the current size of the population. Also, geographically separated economic

¹ Keynes 1930.

units with greater surface areas produced bigger populations and higher densities. In Kremer's approach, demographic transitions, with fertility responding negatively to higher incomes above some threshold level, avoid population size becoming exponentially large as growth accelerates further and further. In exogenous growth models, technology "just happens", and adoption decisions are no longer modelled explicitly. Size itself does not affect technology or productivity change. In one application of exogenous growth to the transition to self-sustaining growth, Hansen and Prescott (2002) model the transition "from Malthus to Solow" by assuming that technological change in both the land-using (diminishing returns) and the non-land-using mode of production was exogenously given and constant. Over the course of each generation of 35 years duration, productivity in their model increases by 3.2 percent in the "Malthus sector" (i.e. agriculture, where labor is subject to declining marginal returns) and by 52 percent in the "Solow sector" (where all factors of production are reproducible). Initially, only the Malthus technology is used. Eventually, as the productivity of the unused technology increases exponentially, the Solow technology becomes competitive and is adopted. In this setup, an Industrial Revolution is inevitable, and does not depend on anything other than the growth rates of productivity chosen for the calibration.

A second class of models in which size matters takes technological change to be exogenous, and models a set of conditions under which new techniques will be adopted. Early models in the tradition of Murphy, Shleifer and Vishny (1989) also relied on demand effects, and hence the size of economies, to explain when a "big push" might occur. In order to pay the fixed cost necessary for adopting modern production, demand needs to be sufficiently high. In typical "big push" models, this is only the case if a whole range of industries industrializes. The chances of this occurring increase with total output. One implication of these models is that industrialization may have been feasible long before it got underway – if only everybody had decided to invest earlier in fixed-cost technology, profits would have been high enough to justify the expense. Advances in technological knowledge themselves need not translate into greater output. Simple coordination failure can thus undermine the transition to modern technology. Possible modifications and extensions of this approach also assign a role to the income distribution and the structure of demand (Zweimüller 2000).

Indivisibilities also play a crucial role in models that put risk diversification at the heart of adoption decisions. Acemoglu and Zilibotti (1997) present a model in which there is a tension between minimum efficient size of new modes of production on one hand, and investment preferences on the other. Productive projects using new technology require substantial setup costs. Households want to diversify their investments to minimize risks. Because of this, investment in the new, productive technology is initially very low. This changes as households become richer – their savings become sufficiently large, relative to the capital requirements of new technologies, to be able to avoid "putting all eggs in one basket". Industrialization, once under way, generates the means with which to sustain itself. It effectively depends on a number of lucky draws, since two identical economies may well end up with very different paths, depending on whether they get lucky in the first round or not. It also has the feature that households do not take into account the effect of their investment decisions on aggregate

productivity, and thus industrialization may be delayed because of a co-ordination failure. The model should be particularly attractive to economic historians in that it incorporates a stochastic component – industrialization may partly be the result of chance. One implication is that not every aspect of actual industrial transformations is fraught with meaning – and the country that actually went first could simply have been lucky.²

Some unified growth models link human capital accumulation with technology and the ideas-producing properties of population growth. Many papers have argued that the transition to modern growth is accompanied by a growing importance of human capital (Becker and Barro 1987, Lucas 2002, Becker, Murphy and Tamura 1990). Galor and Weil (2000) made the nexus between human-capital and technological change a cornerstone of their attempt to understand the transition to rapid growth. They argue that the escape from stagnation took place in two steps – a transition from the Malthusian to a Post-Malthusian state, and then to a Modern Growth regime. Galor and Weil’s key assumption is that, as technological change accelerates, human capital becomes more valuable: it allows people to cope with a rapidly changing workplace. Technological change accelerates as more people produce more ideas during the long Malthusian period. Because of a delay in the response of population to income growth, per capita incomes grow, if very slowly. Eventually, parents invest more in the human capital of their offspring. This in turn accelerates the growth of knowledge. Higher incomes make it easier for parents to have more children. At the same time, a growing value of human capital produces incentives to trade quality for quantity in offspring. First, the income effect dominates, leading to more births; later, the substitution effect becomes more important, and fertility declines.

Sunde and Cervellati (2005) alter this setup by arguing that life expectancy benefits quickly as productivity increases. This in turn encourages investment in human capital, which then helps the economy grow faster. Even if technological change is only slightly skill-biased, a self-reinforcing cycle of better technology, greater life-expectancy, and higher investment in human capital can get started. Jones (2001) combines the population-ideas mechanism with a property rights regime that reserves a share of output for innovators. Based on his calibrations, Jones concludes that the single most important factor leading to a take-off in growth after the 19th century was more effective enforcement of Intellectual Property Rights, which created the necessary incentives for the sector that produced the ideas.

Some observations from economic history

The population-idea nexus is key in many unified growth models. As Crafts (1995) has pointed out, the implications for the cross-section of growth in Europe and around the world are simply

² Following Crafts’ (1977) original contribution, this idea has been the subject of substantial debate amongst economic historians.

not borne out by the facts – bigger countries did not grow faster.³ Modern data show very similar patterns: country size seems to have a negative effect on one of the most reliable correlates of economic growth, the rule of law (Hansson and Olsson, 2006). Even if we substitute “population” with more relevant concepts like market size, which might have influenced the demand for innovation, the contrasting growth records of Britain and France are hard to square with this type of endogenous-growth models.⁴ Moreover, it is disconcerting for these models that in 1750, on the eve of the Industrial Revolution, Britain had just experienced half a century of virtual demographic stagnation. One could also point out that if population size is critical and that it is population growth that “liberates” Malthusian economies from their stagnation, China, where population grew from 130 million in 1650 to 420 million in 1850 yet where no Industrial Revolution could be discerned, should be of some concern. An interesting argument is made here by Justin Lin (1995), in a paper overlooked by many of the growth theorists. Lin argued that the relationship between population size and technological change depends on the source of innovation. In a world in which new technology is based entirely on experience (that is, learning by doing), greater size would imply more innovation, assuming that the advances were disseminated effectively over the larger unit. Once progress begins to depend more on experimentation and theory, such advantages disappear. Lin maintained that the success of China in the Song period as opposed to its relative stagnation in the seventeenth century and beyond were a function of the changing innovation process.

The debate to which extent “size mattered” is complicated by the fact that size has been argued to have influence not only for technological change but also for more traditional sources of growth. The rise of population that took place without a collapse in per capita incomes may have generated positive externalities of a different kind. Regardless whether size mattered to the generation or adoption of new technology, as the endogenous growth models suggest, the oldest and in some ways most elementary of mechanisms – a simple increase in the division of labor as a result of greater population size and density – could also have contributed to an acceleration in output growth. Kelly (1997) presents a model of “Smithian growth” where trade integration is furthered by improvements in transport infrastructure, leading to an acceleration of growth. He applies this model to Sung dynasty China. Similarly, in Europe, higher population densities and greater economies generated the scope for positive externalities, partly through improvements in turnpikes and canals, partly through long-distance trade (Bogart 2005a, 2005b; Daudin 2006).

Models in the “big push” tradition run into similar problems as population-based endogenous growth; the European experience after 1700 does not suggest that absolute size of economies is a

³ It is indeed striking that prior to the rise of the British economy to the fore, Europe’s most successful economies tended to be city states (Hicks, 1969, p. 42). City states, with high density but relatively overall small populations had an advantage in solving the problems of setting up effective institutions of commerce and finance. Market size was less of a problem in part because the fixed costs of setting these institutions up were not all that high, and because they tended to be open economies. The main source of economies of scale was not economic but military. Military power depended on total income and population.

⁴ Some later models in the spirit of Kremer, such as Jones (2001), attempt to provide a solution to this problem by assuming increasing returns in the production of goods and by allowing the number of new ideas to be a function of the existing stock of ideas.

good predictor of the timing of industrialization. Also, the size of the most costly industrialization projects was relatively small – even the largest textile mills, had they been financed by a single person, hardly constituted a large concentration of risk. Before the late nineteenth century, fixed costs in manufacturing were typically small. Much diversification, moreover, could take place *within* the existing business structure of Britain during the Industrial Revolution.⁵ When it comes to production technology with high fixed costs, adoption decisions *after* 1870 could possibly be explained by the big-push framework. Yet by that point in time, international trade was already doing much to break down the link between the size of the domestic economy and the possibility of technology adoption. If there were large fixed costs before 1870 they were in infrastructure, not in manufacturing. In Britain, these infrastructure investments — canals, turnpikes, harbors— do not appear to have suffered a great deal from capital scarcity, the Bubble Act notwithstanding. On the whole, they were financed without too much difficulty by local notables (Michie, 2001).

Finally, unified growth models that emphasize differences in productivity growth between the agricultural (“traditional”) and industrial (“modern”) sector, such as Hansen and Prescott, 2002, also encounter substantial empirical difficulties. At the point in time when overall growth rates began to accelerate, both the land-using sector as well as the industrial sector became more productive – according to some measures, at relatively similar rates (Crafts 1985). By definition, the Hansen-Prescott model has little to say about which country industrialized first, and why – the entire world is its unit of observation.⁶

These observations are not meant as final verdicts on the merits or otherwise of unified growth models. They motivate why we believe we should dig deeper – especially into the interactions between fertility, human capital, institutions, and technology. This is what the following sections do.

2. Malthus Vanishing

Populations grew in most parts of Europe during the early modern period. In some parts, it even surpassed the levels seen before the Black Death. Demographic growth accelerated decisively in many European countries in the late eighteenth century. There was substantial variation in timing, with Britain and Ireland leading the way, and France avoiding a major jump altogether. During the period 1500-1870, the economic impact of demographic factors changed. It went from a crucial determinant of per capita incomes in most parts of Europe to a factor of declining importance as technological change accelerated after 1800. Both growth theorists and economic theorists often refer to the period before 1750 as the Malthusian epoch. We first describe the

⁵ In a recent paper, Pearson and Richardson (2001) show that the typical entrepreneur in the Industrial Revolution was heavily diversified. Rather than describing the entrepreneur as a single-minded owner-manager who spent his entire life on the one business, they show the extent to which early entrepreneurs were involved in non-core ventures. Cotton masters and other textile producers in Manchester, Leeds, and Liverpool, for example, could be found as directors.

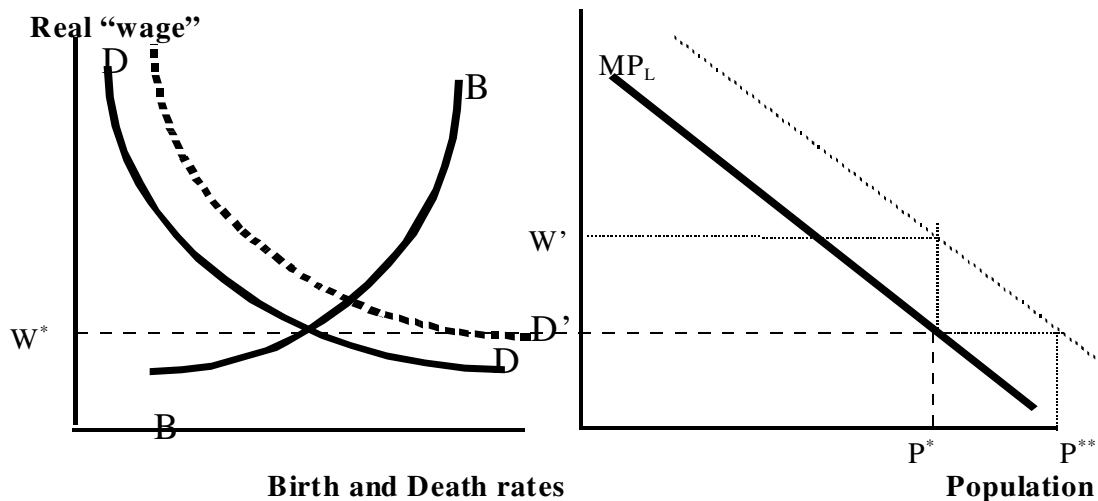
⁶ The only obvious alternative is to posit differential rates of productivity increase in the Solow sector, which would rather be a way of assuming the result.

Malthusian model and key changes in demographic-economic interactions after 1800. We then review the evidence, and summarize what we know about how population pressure eventually fell away as a key economic variable.

The Malthusian model relies on two main assumptions: First, that population growth responded positively to per capita incomes. As wages fall, fertility declines (“preventive check”) and death rates increase (“positive check”). Second, that income per capita was negatively related to population size. A widely-cited example illustrating the tradeoff between incomes and population size is the Black Death. As European populations fell to approximately half of their pre-crisis levels, wages everywhere surged. Living standards in 14th century England, conventionally measured, reached a high not seen again until the 19th century.

Figure 1: The Malthusian Model

Together, the two assumptions underlying the Malthusian model imply that whatever advances in incomes occur will inevitably be frittered away through more babies. In figure 1, birth and death schedules intersect at a wage W^* . The technology schedule in the right-hand panel then translates this into a feasible population size P^* . If a temporary shock drives the wage up to W' , death rates



fall, and population starts to grow. Eventually, because of declining marginal returns, this will force wages down to their previous level. As HG Wells put it, mankind “spent the great gifts of

science as rapidly as it got them in a mere insensate multiplication of the common life.”⁷ Clark (2007) even goes as far as to argue that the English population in 1800 was no better off than their ancestors on the African plains millennia before.

Higher death rates in the model depicted in figure 1 imply higher per capita living standards. Unhygienic conditions and a deterioration of the microbial environment, for example, will boost incomes as they reduce the number of surviving children. Lower fertility rates can achieve the same effect. Europeans in the early modern period reduced population pressure by ensuring that a high proportion of women never gave birth at all. The rest postponed marriage, further reducing fertility rates. This pattern is unique to Europe, and only occurred west of a line from St. Petersburg to Trieste (Hajnal 1965). Other parts of the world, such as China, may have partly achieved a similar effect through infanticide.

At some point, in the majority of European countries, population growth accelerated in an important way. Often, a rise in fertility and/or a decline in mortality signalled the end of the previous regime. Eventually, fertility rates followed the downward trend of mortality – completing the “demographic transition”.⁸ The latest revisions of the Wrigley-Schofield (1997) English population estimates show that fertility increases dominated as a cause of more rapid growth; mortality played a role, but it was responsible for only about one third of the acceleration.⁹ It seems that by 1750, the old demographic regime was breaking down. The work of Patrick Galloway (1988) shows that in the middle of the eighteenth century the short-term behavior of British vital rates was no longer very responsive to changes in prices.

While some of the population explosion in Europe after 1800 derived for a while from higher fertility, declining mortality eventually became more important. Fertility followed, in many cases with a delay measured in decades (Lee 2003, Coale and Watkins 1986). Most of this fertility decline was concentrated in a few decades, starting in 1870 and accelerating after 1890. In some countries, such as the UK, Germany, Sweden, the Netherlands, Finland, and Belgium, there were sustained and sometimes marked increases in fertility before decline set in. For example, the average number of children per woman rose from 4.5 to 5.5 in the Netherlands between 1850 and 1880. By 1900, it had returned to its earlier level. In most European countries, the first significant reductions in fertility occurred after the 1880s, long after industrial change had started to take hold on the continent. Some countries saw large declines in infant mortality before fertility started to decline (Sweden, Belgium, Denmark); in others, both series show a concurrent

⁷ Wells 1905. Galor and Weil (2000) assume that the response of fertility to incomes is delayed. Hence, a one-period acceleration in technological change can generate higher incomes in the subsequent period, and a sequence of positive shocks can lead to sustained growth. While this solves the problem in a technical sense, it is unlikely to explain why fertility responses did not erode real wage gains over hundreds of years.

⁸ A good summary is Chesnais (1992). The concept goes back to the work of Warren Thompson in the 1920s.

⁹ Wrigley (1983) showed that without mortality decline, 18C growth would have accelerated by 1.25 percent; without fertility change, growth would have improved by 0.5 percent. This implies that over 70 percent of the acceleration was driven by changes in fertility. Wrigley and Schofield (1997) qualify these conclusions to some extent, finding a faster decline in mortality, but the relative rankings are unlikely to change significantly.

downward movement (France, Germany, Netherlands).¹⁰ Differences in levels are equally puzzling: Swiss, Belgian, and Swedish birth rates around 1850 were on the order of 30 per 1000, whereas in the Netherlands, Austria and Germany these were around 35 per thousand.

In many models of long-term growth, the fertility transition plays a crucial role. It is normally modelled as a response to changing economic incentives. The standard argument is that (i) skill premia surged, often because of technological change, (ii) parents limited fertility as a response to this change in the trade-off between child quantity and quality. Yet definitive evidence for both these arguments is lacking. What is more plausible is to argue that the net *costs* of child quantity increased in the second half of the nineteenth century as a result of compulsory schooling laws and child-labor prohibitions. Doepke (2004) argues that other government policies (such as education subsidies) could not have had a similarly large influence. We do not know that government intervention was crucial in moving children out of the factories and into the classrooms. For the US, there is some evidence that state schooling laws had only a small influence on child labor (Moehling 1999). In the UK, Nardinelli (1980) and Kirby (1999) argue that child labor laws came in at the same time when technological changes made the use of children in mining much less useful, and that there was not much of a causal role for government legislation in reducing employment rates.

Until recently, the demographic transition was considered a more controversial and potentially challenging topic of research than the mechanisms that controlled the pre-industrial (Malthusian) era. This has begun to change. There are two versions of the Malthusian model. The model in its strongest form has its roots in the classic “iron law of wages”. Without shifting mortality and fertility schedules, it predicts stagnant real wages. Without technological change, population size will stagnate. The weaker version emphasizes equilibrating mechanisms. The positive and preventive check identified by Malthus influence demographic growth. Only if the responses are sufficiently large, and without further perturbations does the weak version lead *in the limit* to a return to a subsistence wage.

It is clear that the strong version – with stagnant wages at the subsistence level – can claim little empirical support. Stock variables like population size are invariably slow-moving. Shifts in mortality schedules (possibly as a result of urbanization) could produce new equilibria, but our chances of observing them will depend on the relative magnitudes of short-term to enduring shifts. For England, the real wage data computed by Clark (2005, p. 1311) replaces the traditional wage series computed by Phelps-Brown and Hopkins and is based on a much broader array of commodities and a more comprehensive set of nominal wages. Both show the same, rather miraculous sharp decline of wages in Tudor England between 1495 and 1575, a decline that was accompanied by stable and then rising population as well as an unusually long life expectancy. Recent calculations by Allen (2003) and others show that in the long-term, wages in Europe follow divergent trajectories. Northwestern Europe saw marked rises in wages, often at the same time as population increased. This would contradict the strong version if both North and South

¹⁰Chesnais, 1992.

were subject to Malthusian forces. Furthermore, some of the debate regarding the outcome of Malthusian processes conflates real wages with real per capita GDP or income. This is problematic because participation rates may have risen and seasonal unemployment reduced, leading to a considerable rise in incomes per capita and per family even at more or less constant wages. Indeed, rising participation rates could, all other things equal, lead to real wages and real income per capita to move in *opposite* directions. The rise of cottage industries in the countryside after 1650, the famed “protoindustrialization” phenomenon, would do exactly that. There is also reasonable evidence to believe that labor participation rates were rising in the century before the Industrial Revolution (De Vries 1994; Voth 1998, 2001, 2001b).

Confronting the model’s predictions in its weaker form – with an emphasis on equilibrating mechanisms – is less demanding. We can observe flow variables such as births and deaths at high frequencies, and relate them to food prices and real wages. Over the short run, movements in population before 1750 seem to offer some support for a Malthusian response.¹¹ Mortality and nuptiality can adjust even over the short run. High-frequency events like famines, wars and epidemics had much smaller long-term effects than often assumed: a sharp decline in population was normally followed by higher wages. Within a few years, unusually high birth and low death rates would compensate for the initial decline in population (Watkins and Menken, 1985; Watkins and Van De Walle, 1985). Lee’s original work on the Wrigley-Schofield population data showed nuptiality responding (weakly, and with a lag that stretches credulity) to wages, but life expectancy to be largely independent of the wage. Patrick Galloway (1988) demonstrated that, in many European countries, vital rates were responsive to grain prices in the way that the model predicts.

For both the weak and the strong version of the Malthusian model, endogeneity is a major challenge. Wages influence population size and vice versa. One potential way forward is to use an exogenous source of identification. Recent work by Kelly (2005) suggests that weather is a useful instrument for wages – the part of real wage variation that is driven by it is not the result of a feedback from population. Estimated in this way, there is strong evidence that Malthusian restrictions bound in England before 1800, with marriage rates reacting strongly (and positively) and death rates strongly (negatively) to wages changes. Kelly’s findings suggest that passing real wage fluctuations had a larger effect on nuptiality than on mortality. This implies that, in the short-run, the preventive check was stronger than the positive one, but both were significant.

Vector autoregressions offer an alternative method. Nicolini (2007) and Crafts and Mills (2007) use them to model the dynamic feedback between fertility, mortality, and the real wage in England. In this way, they examine the strength of the preventive and the positive check. Both papers find much stronger evidence in favor of Malthusian checks and balances for the period up to the middle of the 17th century than for the later decades. The fertility channel is particularly potent, while the mortality channel is often weak. After 1650, the fertility channel also starts to look unimportant. As Nicolini (2007) argued: “perhaps the world before Malthus was not so

¹¹ See e.g., Galor (pp. 183-184) for some graphs that indicate that in pre-industrial Britain population and real wages moved roughly in opposite direction and that crude birth rates and crude death rates were negatively correlated.

Malthusian”. As is the case with all negative results, it is not always clear if it is lack of power in the statistical procedures used, a shortage of identifying variation in the data, or the true absence of a causal link that causes it.

Some progress has been made in terms of analysing short-term responses. The precise contribution of demographic factors to divergent per capita incomes in early modern Europe remains largely unclear. Golden-age Holland had exceptionally high wages compared to the rest of Europe, and stagnant population. It is not clear what particular feature of fertility behavior or of death schedules (if any) accounts for this beyond the high levels of urbanization. The Dutch example suggests that, while the Malthusian adjustment mechanisms may have held in the short run, many interesting shifts were caused by other factors. Since the late middle ages, there were throughout Europe regions and towns in which incomes exceeded subsistence levels, without a concomitant rise in population size. Some of unified growth models (Galor 2005, Jones 2001) predict (modestly) rising living standards before the Industrial Revolution. This is on the whole confirmed: living standards drifted up, albeit slowly, in the centuries before 1800. The reason proposed, a delayed response of population to technological advances, is not altogether persuasive: total fertility rates for females in many pre-modern populations (and especially European ones) were substantially below their biological maximum. Birth rates rebounded vigorously after each famine. This suggests that they could respond to rising living standards. One important question then is why Europeans curtailed their fertility, and how the social institutions underpinning the “European marriage pattern” evolved. One interesting hypothesis links the emergence of fertility restrictions to the high price of labor after the Black Death (Van Zanden and De Moor 2007), which made female workers more valuable. This would have made it beneficial to keep them in the workforce as long as possible, and to delay motherhood. But why did this mechanism work in the Netherlands and not, say, in China or India? This question is particularly relevant since they also suffered numerous plague outbreaks, some of which were similarly severe to the Black death in 1348 (McNeill 1977).

One way of linking the persistence of high wages with specific European features involves the interaction between cities and death schedules. European cities were veritable death traps with far higher mortality rates than the countryside. In contrast, China and Japan, urban and rural mortality rates were very similar (Woods 2003). Different cultural practices, such as the regular removal of excrement from Far Eastern cities, appears to have played an important role. Not only were European cities far more unhealthy places to live in under normal conditions (due to congestion and poor sanitation), but they were especially sensitive to contagious epidemics and military disasters such as sieges and plunder. Hence the curve D, which is a composite of rural and urban demographic behavior, could slope upwards *over some part of the w-D space* because of this composition effect. There could then lead to multiple equilibria: societies could fluctuate between one state where population was large, wages were low, cities small, and aggregate death rates low, and another one where wages were higher, cities larger, death rates higher, and

population smaller. A major shock, such as the Black Death, could push the economy from one equilibrium to another.¹²

Cities mattered for reasons other than excess mortality. They were the loci of much international trade, of private-order institutions that supported the operation of the market, the generation of some new techniques, and the like. What this means is that at any level of population, income would be higher with a larger urban sector, which would go some distance to explain the Dutch “anomaly.” This means that far from being simply an indicator of productivity, urbanization itself can become a driving force increasing output per head. In addition, if urban activities produced a higher likelihood of inventing new techniques with a large economic impact, technology itself could have improved as a result of urbanization (Clark and Hamilton 2006; Voigtländer and Voth 2006). City growth may therefore have gone hand-in-hand with a slow, gradual outward shift of the technology schedule, making higher wages compatible with bigger populations. In this case, Malthusian forces could still dominate short-run changes, but the key *explanandum* would no longer follow from its basic tenets.

The iron law of wages, however, probably did not apply in Europe before 1800. A substantial amount of evidence points to problems with the blind acceptance of the Malthusian model in its strong form (Clark 2007). We do not know if it ever applied fully. When we can comment on the strength of the connection, it seems that many mechanisms were breaking down quite some time *before* the Industrial Revolution proper.

That population growth after 1750 accelerated is well-documented; the literature has not provided a single “unified” explanation of how and why it happened. Models that link population dynamics to technological progress itself, such as Galor and Weil (2000), run into timing problems in the case of Britain because demographic growth accelerated in the mid-eighteenth century, *before* any serious impact of technological change on output per capita can be discerned. The breakdown of the demographic ancient regime in Europe in the second half of the eighteenth century is one of the biggest events in demographic and economic history that remains less than fully explained both from a theoretical and an empirical angle. It spread through many parts of Europe, regardless of their level of industrialization and the speed and nature of the industrialization process seem to have been unaffected by the decline in mortality. Perplexingly enough, the mechanism through which population increased seems to have differed from country to country. In some, such as Britain, increases in fertility are equal to or larger than the contribution of mortality. Elsewhere, birth rates stayed constant or even declined from an early date, as they did in France. There, mortality decline accounts for almost all of the population growth.

During the second part of the demographic transition, fertility declined. This eventually occurred everywhere in Europe; it happened much earlier in France and Belgium than for instance in Britain or the Netherlands. Finding an economic reason for fertility decline has not been easy, and there is currently no consensus on the principal contributing factors (Alter 1992). Both

¹²Such a model is developed in Voigtländer and Voth 2007.

variation across Europe and over time present challenges of interpretation. The biggest comparative project on the fertility transition, the Princeton European Fertility Project (EFL), concluded that there was no clear link between socio-economic factors and fertility change. Instead, ethnic, religious, linguistic and cultural factors appeared to be dominant (Coale and Watson 1986). Woods (2000) reached a similar conclusion for Britain, attributing the Victorian decline in fertility to changing ideology, primarily “the desire or willingness to limit family size from the 1860s on” (p. 150) and suggests, more provocatively that “the very question ‘how many children should we have’ was new to most Victorians” (p. 169). The economic value of children, as far as it can be determined, did not change in such a way as to help in explaining the decline in fertility rates (Knodel and van deWalle 1986). The leading explanation for fertility change is the “diffusion model”, where knowledge about prophylactic techniques spread along linguistic lines. The principal reason why scholars have accepted the findings of the EFL is the remarkable similarity in the timing of the transition, and its spread along linguistic lines.¹³

Studies that go beyond the broad aggregates and look at regional data sometimes reach different conclusion. For example, in Bavaria, the opportunity cost of women’s time, religion and political affiliation appear to have played a big role (Brown and Guinnane 2002). Also, the statistical basis for some of the EFP’s conclusions may be less robust than had previously been assumed.¹⁴ Independent of whether new, more disaggregated studies can find a role for economic factors in fertility change, the very simultaneity of the drop in reproduction rates across Europe in the decades before 1914 makes it unlikely that economic factors can ever be assigned a dominant role. Exogenous, non-economic factors probably dominated in the great decline of European fertility. This need not present a challenge to all growth models. Yet for the more ambitious class of structural models in the unified growth tradition, the apparent incapability of economic factors to have a clear bearing on fertility outcomes represents a challenge.

The timing of fertility decline is crucial for many theories explaining the transition to self-sustaining growth. Leading interpretations by theorists such as Becker and Barro (1987) and Lucas (2002)) emphasize the quantity-quality tradeoff in a context of faster technological change and higher returns to human capital. This is not unproblematic. Returns to human capital, conventionally measured, probably did not increase significantly before 1870. Since the economic benefits of formal education were probably minor for working class employment, any model of parental fertility choice based on quality-quantity tradeoffs faces problems. They explain at best the demographic behavior of a minority group. An alternative interpretation emphasizes the importance of government intervention through schooling laws and child labor regulations. If the importance of government intervention suggested by Doepke (2004) and Doepke and Zilibotti (2005) is confirmed, examining the economic and other factors behind the adoption of child labor laws becomes crucial. Galor and Moav (2006) emphasize that the Balfour Act introduced compulsory schooling. In their view, support by capital

¹³As Cleland and Wilson (1987) argue: “...the simultaneity and speed of the European transition makes it highly doubtful that any economic force could be found which was powerful enough to offer a reasonable explanation”.

¹⁴A much larger research project on German fertility decline is now under way (Ogilvie et al. 2005), using that country’s extraordinarily rich data sources.

owners, who needed more skilled labor, was critical. The failure of skill premia to rise can then be explained by this supply shock.

Some data constraints will be hard to overcome. We have little information on what determined completed fertility rates, educational investment, age at marriage and the like in the industrializing cities of Northern England. There are no cohort-specific studies of fertility behavior at the micro level that would unambiguously identify the impact of discontinuous changes in schooling laws and the like. Wrigley and Schofield's famous *Population History of England* is based on family reconstitutions that focus on rural parishes, and their data end in 1837. Everywhere in Europe, family reconstitutions are harder to construct for the 19th century than for earlier period because mobility increased. Future research should aim to improve our understanding of fertility behavior, and of the relevant costs of child-rearing. More detailed demographic analysis of the fertility choices of the working class – combined with information on rates of school attendance, the economics of apprenticeships and the like prior to and after the introduction of the compulsory schooling laws – could do much to further our understanding of how important human capital was for the demographic transition.

Institutions, Good and Bad

A good part of the modern debate about growth centers on the relative importance of institutions versus human capital (Acemoglu and Johnson 2004; Rodrik et al., 2004; Glaeser et al. 2004,). In cross-sections of countries from the late 20th century, constraints on the executive tend to be positively correlated with higher per capita output. Because of the potential for reverse causation— with higher income per capita improving institutional quality — work on modern data has principally focused on finding an exogenous factor that affect institutions, but not economic outcomes and so can be used to instrument for institutions. One such factor that has been used with great success is historical settler mortality. In a series of path-breaking papers, Acemoglu, Johnson and Robinson (2001) show that countries in which white settlers survived easily also ended up with more desirable institutional arrangements. They are markedly richer today, making it more likely that the link between institutions and efficiency is causal.

How much can institutional interpretations help us understand growth in Europe before 1870? What is the role of institutional change in the transition to self-sustaining growth? We will emphasize two points. First, any analysis of institutions in a historical setting needs to look beyond the role of the state and constraints on the executive, and to focus on legal processes and informal institutional arrangements as well. Second, and despite the wide-ranging claims that have been made, we do not know nearly enough about how institutions worked in Europe between 1500 and 1870 to pass judgement on their overall contribution to economic growth.

Possibly the single best-known statement in the institutional tradition was formulated by North and Weingast (1989). They conclude that the Glorious Revolution and the Bill of Rights in England in 1688-89 did more than just put government finances on a firmer footing. Because of the boost to parliament's role and the greater influence of the common law courts, the English monarch's power had been curtailed. Crucially, it was widely viewed as such because credible

commitment. High-handed breaking of contracts and seizure of property came to an end.¹⁵ North and Weingast argue that, once property rights and constraints on the executive had been firmly established, risk premia fell. Capital accumulation accelerated, and investing in new ideas became much more profitable. Eventually, Britain's growth rate took off.

Most institutional interpretations of the early modern period similarly focus on capricious despotic rule falling away first in some parts of Europe, then in others. Following the work of North and Weingast, numerous scholars have tried to use institutional analysis to explain divergent growth records. DeLong and Shleifer (1993) return to Montesquieu's famous argument that growth is more vigorous in Republican states, because they suffer fewer arbitrary interventions by the authorities.¹⁶ They argue that absolutist rule was harmful because of three reasons – centralized powers run by ambitious, powerful princes fought more wars, taxed more comprehensively, and respected property rights less. Autocratic states also happened, on average, to be further away from the new trade routes to the Americas and Asia. It should be noted that only one of these channels is directly associated with the institutional interpretation in its narrow form, and DeLong and Shleifer cannot show that it is particularly potent.

A more recent paper by Acemoglu, Johnson and Robinson (2005) argues that two of the channels identified by DeLong and Shleifer interacted in a particular fashion to strengthen institutions. Countries that had opportunities for Atlantic trade experienced a gradual strengthening of bourgeois forces in society. Hence, "constraints on the executive" in Britain and the Dutch Republic grew, according to their estimates. AJR demonstrate that this improvement in the quality of institutions mattered for growth – urbanization rates surged wherever geographically-determined "exposure" to the Atlantic trade was high.

¹⁵These had previously been possible both through the legal system – namely the Star Chamber – and brute force (such as in the raid on the Tower of London, when the gold of goldsmiths was seized).

¹⁶"An opinion of greater certainty as to the possession of property in these [republican] states makes [merchants] undertake everything.... [T]hinking themselves sure of what they have already acquired, they boldly expose it in order to acquire more...".

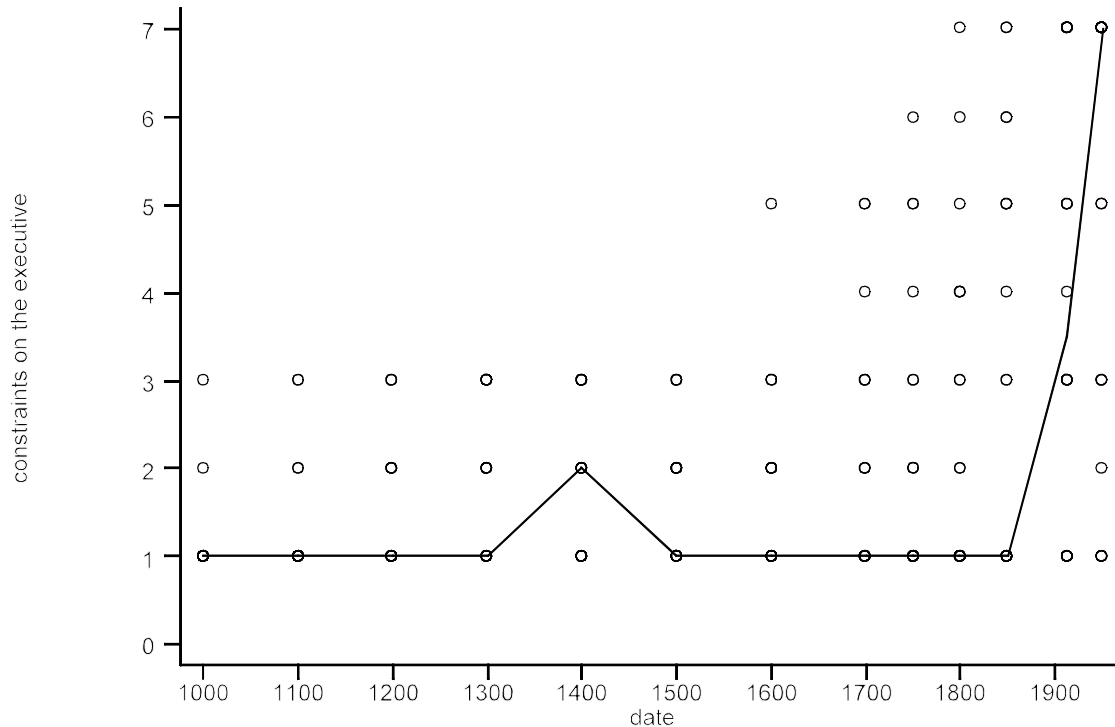


Figure 2: Dispersion and Median Score, Constraints on the Executive, Europe 1000-1950 (line shows median)

Source: Data appendix, Acemoglu et al. 2005

Institutional interpretations of the Industrial Revolution and its aftermath have emphasized the role of political economy. For the case of Britain after 1800, Acemoglu, Johnson and Robinson (2005) and Acemoglu and Robinson (2006) have argued that political power mattered in large part because it made the redistribution of income possible. They distinguish between *de iure* power, that is, the power to pass formal laws and statutes, and *de facto* power, which includes the physical ability to overthrow the regime if those who have it do not find the policies to their taste. While by 1720 Parliament concentrated a great deal of *de iure* power and had thus elevated itself to the status of a meta-institution, it still needed to be concerned with the *de facto* power of the large masses of middle class people who accumulated increasing economic wealth and yet were to a great deal disenfranchised until the reforms of 1832 and 1867. The same authors (AJR 2006) argue that the French Revolution acted as an exogenous shock to the political system of neighboring states. Defeat at the hands of Napoleon's armies prodded rulers in Prussia and Austria into major reforms. Elsewhere, conquest by the French swept away old political and social institutions in their entirety. Combined with the rising tide of technological change after 1850, the authors argue, the improved institutions of the set of countries ringing France accelerated growth in the early 19th century in an important way.

Institutions have thus gained a great deal of credence in the modern growth literature (Rodrik et al., 2004; North, 2006). Yet interpretations of Europe's growth record that rely primarily on

institutions face numerous challenges. To start with, few scholars agree what institutions are, and how the concept should be applied to the past. North defined them as “a set of rules, compliance procedures, and moral and ethical behavioral norms designed to *constrain* the behavior of individuals in the interests of maximizing the wealth or utility of principals.” Greif (2005) includes other modes of behavior that create historical regularities. In Greif’s model, beliefs and ideology act as “deep” parameters that determine the efficacy with which societies set up rules making exchange and investment possible. Yet there are few good theories that explain in detail how institutions change and why some economies end up with “better” ones than others. Standard measures in the literature such as the (perceived) risk of expropriation, government effectiveness, and constraints on the executive – can all easily reflect choices by governments, and may change quickly. For any model that implies that better institutions work wonders through capital accumulation or technological progress, this would be problematic. Glaeser et al. (2004) show that all three standard measures of institutions often change after a single election. Presumably, property rights that are simply protected because of a ruler’s whim are not worth a great deal. The volatility of these measures over time makes it less likely that they identify some structural parameter of the political system. Other, more obvious variables such as judicial independence, proportional representation, and constitutional review, vary much less and are more likely to proxy for the structural constraints on governments that North had in mind. Yet in modern-day data, the effect of these variables is small and insignificant. What would be needed to settle the matter is a “deep” parameter of a country’s political constitution that does not change quickly, and that is not simply a reflection of current economic and political conditions.

For the period 1500-1800, “constraints on the executive” variable, as compiled by Acemoglu et al., successfully predicts urbanization rates. The same is true of DeLong and Shleifer’s absolutism indicator. Yet both concepts are troubling for the early modern period. Data problems abound, and coding variables based on the complex institutional arrangements in place in many European states before 1800 is not a challenge for the faint-hearted. The Habsburgs ruling Spain, coded as perfectly absolutist by AJR for the 16th century, often failed to get tax or other concessions from the Cortes of Castile. In their other kingdoms, such as Aragon, many medieval “freedoms” and the assemblies that protected them curtailed the monarch’s powers. Even for that epitome of absolutist rule, the Sun King Louis XIV (and coded as a perfectly unconstrained “1” by AJR), there are important question marks. Historians have largely rejected the idea that his rule can meaningfully be described as an implementing a successful, far-reaching absolutist agenda. For a generation, a new consensus inspired by the works of, inter alia, Georges Pagès and Roland Mousnier (1970) has emphasized how much French kings at the height of absolutism still governed through social compromise and consensus, maintaining the stability of a traditional society and the influence of old elites for much of the time. Even if revisionism along these lines has gone too far– it seems doubtful that the currently available classification schemes capture enough of what is directly relevant to the argument that institutions and restrictions on executive caused economic growth before 1800.¹⁷

¹⁷ For a recent critique of the revisionist argument, cf. Beik 2005.

States with extensive checks-and-balances, such as Venice, the Holy Roman Empire and Poland, constrained their rulers' freedom of action. Yet they did not become invariably hothouses of economic dynamism. This may be because fettering the prince was neither unambiguously good or bad in economic terms before the rise of modern, centralized states with clearly defined and stable borders. The late S.R. Epstein (2000) has emphasized the advantages conveyed by a powerful state that could curb local rent-seeking and resolve coordination problems. Most of "constraints on the executive" took the form of rent-seeking groups ensuring that their share of the pie remained constant. Unsurprisingly, large parts of Europe's early modern history read like one long tale of gridlock, with interest groups from local lords and merchant lobbies to the church and the guilds squabbling over the distribution of the economic pie. None of the groups that offered resistance to the centralizing agendas of rulers in France, Spain, Russia, Sweden, and elsewhere were interested in growth – nor did they ensure that sensible, long-term policies were enacted. They often replaced arbitrary taxation by the ruler with arbitrary exactions by local monopolies.¹⁸

One of the reasons why good institutions by modern standards were so weakly correlated with riches before 1800 has to do with the cut-throat nature of international politics. Few doubt that the events following the League of Cambrai (1516) laid Venetian power low, and contributed to the eventual decline of her prosperity. Today, constraints on the executive go hand in hand with lower probabilities of military conflict, as democracies are unlikely to go to war with each other (and tend to win in wars against non-democratic powers). In the early modern period, the correlation probably had the opposite sign. The political entities with highly effective constraints on the executive quickly became victims of outside powers whose rulers operated without being hamstrung by domestic opposition. Thus in early modern Europe, less-developed but large and militarily strong political units, such as the young nation states of Philip II, Gustavus Adolphus, and Louis XIV, threatened the richer but smaller city states of Italy, Germany, and the Low Countries. This military imbalance created a basic source of instability and inefficiency in the history of European cities. Economically successful but compact units were frequently destroyed by superior military forces or by the costs of having to maintain an army disproportionate to their tax base.¹⁹ The only two areas that escaped this fate enjoyed unusual geographical advantages for repelling foreign invasions – Britain and the northern Netherlands. Even these economies were burdened by high taxation, the cost of surviving in a mercantilist world based on the notion that the economic game between nations was zero-sum, and that foreign trade was a servant of political and dynastic interests.

Constraints on the executive, carried to the Polish extreme, were not conducive to economic

¹⁸ The case of Venice is instructive. In terms of its institutional setup, it is hard to think of a political entity that would more closely approximate the modern ideal. Property rights were well-protected. The high bourgeoisie controlled politics and the courts. Doges were elected officials, theoretically for life; in reality, subject to good performance. A patent system was in place as early as the fifteenth century. Yet despite its early riches and success as a sea power, Venice declined both as a militarily and economically.

¹⁹ In modern data, there is a robust, negative correlation between military conflict and political instability on the one hand, and growth on the other (Alesina et al. 1996).

development – not least because they could have contributed to the disappearance of the state itself at the end of a sequence of grueling military defeats. A fundamental trade-off was thus created: a powerful central government was more effective to protect an economy from foreign marauders, but at the same time the least amenable to internal checks and balances. The effect of “constraints on the executive”, properly measured, on growth has to be a composite of the (positive) effect for property rights, as well as the negative effects through the continued influence of rent-seeking groups, and the (similarly negative) effects of political instability and military defeat. Recognizing the ambiguous nature of constrained power can help us understand one prominent feature of early modern growth – repeated but brief efflorescences of prosperity (Goldstone, 2002).

Two observations to summarize the importance of institutions in the post-1750 transformation of Europe are in order. One is that throughout Western Europe we observe after 1750 a rising tide against the rent-seeking institutions that are associated with the mercantilist *ancien régime* (Mokyr, 2006). The roots of this reaction involve some combination of the changing political influence of economic elites and the influence of a more liberal ideology. Second, change often occurred by force (in the United States and France). The main exception is Britain, where the existence of a meta-institution (i.e., Parliament) could adapt to changing circumstances and beliefs and reform the system peacefully and without major upheavals (Mokyr and Nye, 2007). Yet even here it could be argued that the settlement following the Glorious Revolution would not have been possible without the bloodshed of the Civil War.

The literature on institutions in Europe, 1500-1870, has primarily focused on the state and formal institutions. Non-governmental institutions, both formal and informal, have received much less attention (but see Mokyr, 2007). This is striking since work on the medieval period has given prominence to these arrangements (Greif, 2005). If, as the institutions literature argues at a fundamental level, respect for property rights and recourse to due legal process are key for economic development, then we need to construct variables that more closely capture this dimension.²⁰ A more comprehensive and historically meaningful set of indicators should measure effective, legal or customs-based constraints on the actions of the executive or of local power groups – anything that makes it harder for might to be right, without due recourse to the law. In addition, opportunistic behavior leading to Pareto-dominated equilibria could be overcome by a host of mechanisms (besides the standard of third-party enforcement) in which members of select groups were able to establish their trustworthiness through a variety of costly signals (Greif, 2005) and play cooperatively. The modern literature on institutions has shown that such arrangements may still have a fair amount of explanatory power today (Ellickson, 1991; Posner, 2000). They need to be investigated for periods not covered by Greif, and their significance relative to that of formal institutions such as Parliament.

²⁰ Acemoglu and Johnson (2005) argue that institutions protecting property are crucial, and that “contracting institutions” only influence the type of financial intermediation one ends up with.

Eighteenth-century Britain is a case in point. In a recent paper, Mokyr (2007) has argued that informal arrangements and cultural change had effects similar to public institutions, facilitating the operation of markets. Within a larger group of people, a stable equilibrium emerged that allowed signaling of trustworthiness. Middle class people adopted certain virtues associated with gentlemanly behavior; since gentlemen were supposedly indifferent to wealth and not greedy, they could be expected in probability to cooperate in one shot p.d. games. Moreover, Britain in the eighteenth century experienced an enormous growth in formal and informal social networks in eighteenth century, through the growth of friendly societies, masonic lodges, and eating clubs, with an estimated membership of 600,000 in 1800. The effect of this growth was to make reputational mechanisms more effective, since non-cooperative behavior would soon be disseminated. It can be argued that such informal institutions not only supported markets, but also helped Britain take the technological lead, because the success of these informal institutions made its apprenticeship system particularly effective (Humphries, 2003). The apprenticeship contract was particularly vulnerable to opportunistic behavior, and in Britain the guild system that enforced it elsewhere was weak — yet it functioned well in Britain. As a consequences Britain could count on a large number of highly skilled craftsmen and mechanics, whose role in the Industrial Revolution was critical.

Power-sharing arrangements between nobility and the rich bourgeoisie after 1830 underpinned some of the smooth functioning of institutions in Britain, as Acemoglu and Robinson emphasize. Workers may not have had *de iure* power, but their implicit ability to rebel gave them *de facto* power. It is worth pointing out, however, that their account to date does not stress the growing influence of Enlightenment ideology on political institutions, and that the full analysis of what *de facto* power consisted of is still incomplete. The British military suppressed popular unrest in the 1790s as well as the Luddite riots very effectively, and the Chartist movement remained a mostly non-violent movement, its few more threatening outbursts readily suppressed. . It may thus be that *de iure* and *de facto* power coincided to a great extent. Perhaps this was the key to the success of Britain's political model. It is striking, nonetheless, that while those who had political power did use it at times to redistribute income to themselves (most blatantly by the reformulation of the Corn Laws in 1815), the tendency to do so lessened as the nineteenth century wore on, and by 1860 rent-seeking in Britain was at a historical nadir.

3. Human Capital and Culture

In many models of long-run growth, the transition to self-sustaining growth is almost synonymous with rising returns to education, and a rapid acceleration in skill formation. Becker, Murphy and Tamura (1990) model an economy without a fixed factor of production. Improvements in human capital in turn directly feed into higher output. Human capital is produced, it is assumed, by investments of parental time. Parents maximize their own utility, derived by their own consumption, the number of children they have, and their quality. When parents start to invest massively in the education of their offspring, growth rates rise. Once incomes are high enough, fertility falls, leading to yet more investment in child quality. In this model, human capital and growth are almost identical. Lucas (2002) extends the Becker et al.

approach by adding a land-using sector with diminishing returns, and a modern sector where human capital enters linearly. Many unified growth models have followed in the same direction, adding interactions with the rate of technological change.

Other authors have also argued for institutional responses after the onset of rapid technological change. Doepke and Zilibotti (2005) conclude that child labor laws were introduced in England after wage inequality surged. In their model, the political equilibrium that sustains restrictions on child labor require a substantial premium for well-educated members of the workforce. In this way, there is an institutional response to the voracious demand for human capital. Galor and Moav (2006) argue ingeniously that human capital was highly complementary with physical capital, and that therefore capitalists had an incentive to support and subsidize education. Since compulsory schooling played a crucial role in raising human capital, examining the history of their introduction becomes crucial. Galor and Moav offer a first step in this direction. They analyze voting records in the House of Commons, and argue that the educational reforms that came into force as a result of the Balfour Act of 1902 largely reflected the interests of capitalists in improving workers' education.

Developments during the Industrial Revolution in Britain appears largely at variance with these predictions. Most evidence is still based on the ability to sign one's name, arguably a low standard of literacy (Schofield 1973). British literacy rates during the Industrial Revolution were relatively low and largely stagnant. This is especially true if we take into account that Britain was relatively rich before the Industrial Revolution, and that demand for literacy rises with income (Mitch 1992, 1999). Britain's ability or willingness to educate its young did not appreciably improve during the years of the Industrial Revolution. School enrollment rates did not increase much before the 1870s (Flora et al 1993).

One factor that is common to models in the Lucas tradition is that they predict an increase in the demand for human capital during the transition to self-sustaining growth – and that technological change should be heavily skill-biased. This is historically problematic. Our knowledge of the behavior of the skill premium over time is incomplete, because estimates are based on a few skilled occupations, which may not be representative. Moreover, the skill premium is a reduced form measure, and changes in it could reflect any combination of changing supply and/or demand factors. There is little firm evidence of an increase in the returns to education in the eighteenth or nineteenth century. Williamson (1985) claimed to show that the skill premium surged between 1750 and 1850 in Britain, and declined thereafter. The consensus view amongst economic historians does not accept the Williamson interpretation. As Feinstein (1988) convincingly demonstrated, there is no clear evidence that skill premia changed at all over time.

It is far from clear that the main developments in manufacturing during the Industrial Revolution, or even developments in its aftermath, depended heavily on an increase in human capital. Possibly, some administrative tasks became more important, and the rise in pay rates for highly literate workers observed by Boot (1999) suggests that there were some (small) parts of the economy where formal education may have paid off. Yet technological change itself was

probably not skill-biased. As the machine-breaking Luddite riots highlighted, it may well be that de-skilling accompanied the first Industrial Revolution.²¹ This would present an important challenge to the dominant economic models of long-run development. In the textile industry, the cotton mules, spinning jennies and Arkwright frames replaced skilled labor with a mixture of capital and unskilled labor. For larger sectors, the evidence is much more mixed. Clark (2007) examined the ratio of craftsmen to laborer wages in England, 1700-1850. It shows a decline from a premium of 65 percent to 50 percent. Of course, the building trade experienced limited technological change. If the sector is nonetheless indicative of broader trends in the economy, then one would have to conclude that mild deskilling occurred in the one and a half centuries before 1850. Research on the output of textile workers in New England, as late as early 20th century, shows that only experience was a good predictor of output. The ability to read or write was neither useful in its own right, nor did it go hand-in-hand with other, unobserved characteristics that would have raised output (Leunig 2001).

Also, for the time being, the jury appears to be out on whether increased human capital formation from the middle of the nineteenth century onwards was an endogenous response to changes in factor prices and other economic incentives, whether it was a result of higher real incomes (education for one's children being a normal consumption good), or whether it was the result of "exogenous" shifts in the supply of education, such as the long-delayed effect of the Enlightenment, of nineteenth-century nationalism and nation-building, or attempts to strengthen social control over the lower classes.²²

There is little evidence to support unified growth models if we identify human capital with formal education only, and the break with the pre-Industrial period as occurring in Britain after 1750. The main conclusion appears to be that, while human-capital based approaches hold some attractions for the period after 1850, few growth models have much to say about the first escape from the low growth regime that survives contact with the basic facts in economic history. Our verdict changes somewhat as we widen our focus. As we turn from the particular case of England to trends in Europe as a whole, analyse the longer period 1500-1870, and include broader definitions of human capital to include factors such as numeracy and discipline, as well as informal education mechanisms such as apprenticeship, the fit between theory and history increases.

There is no doubt that some forms of human capital (such as literacy and numeracy) were on the rise in Europe long before the Industrial Revolution. In part this was due to the Reformation, in part due to slowly rising incomes, and possibly to a rising demand for literacy in the service sector during an age in which commerce and finance were growing rapidly. Measuring literacy

²¹ Adam Ferguson, Adam Smith's contemporary noted in 1767 that "Many mechanical arts require no capacity ... ignorance is the mother of industry as well as superstition... Manufactures, accordingly, prosper most where the mind is least consulted." For a recent model emphasizing the role of deskilling, cf. O'Rourke et al. (2007).

²² The latter effect would be in the spirit of Acemoglu and Robinson's (2001) paper, which sees the extension of the franchise as a reaction to revolutionary threats. A similar argument could possibly be made about the introduction of compulsory schooling.

rates in a consistent and comparable fashion is no minor matter, especially with the kind of pre-1800 sources available. A recent literature survey, focusing on the ability to sign one's name in around 1800, rates this proportion at about 60 percent for British males and 40 percent for females, more or less at a par with Belgium, slightly better than France but worse than the Netherlands and Germany (Reis, 2005, p. 202). Baten and van Zanden examined book production in early modern Europe. They find a veritable explosion of output per capita after the invention of moveable type, with production increasing between ten- and a hundredfold. The Netherlands and the UK are far ahead of other countries – the richest areas consumed the largest number of books.²³

One additional measure of human capital is numeracy. The ability to make sense of numbers, to remember them correctly and perform minor transformations is a crucial skill in many commercial transactions. Measurement in a historical setting can be achieved via a shortcut. As suggested by Mokyr (1985), we can use age-heaping as an indicator of numeracy. Many historical sources show a tendency for ages to be reported in multiples of five, while the true distribution should be smooth. A'Hearn, Baten and Crayen (2006) have recently begun to compile a comprehensive database for the last two millennia. They find some evidence that numeracy was trending upwards in Europe from the 16th century onwards. The more evidence we can collect on areas outside Europe, and the closer they can be linked to data on pay differences as a result of higher numeracy, the more potent tests of models in the Becker and Lucas tradition become.

If we are to make progress, historians and economists need to accept that until the nineteenth century, "skills" were not yet, as a rule, acquired at schools or similar formal institutions, but were transmitted through personal contracts. The main form that training took was apprenticeship, in which a contract between the trainee and the master involved an indenture, a commitment by the trainee to work during his learning period, and at times cash payments by parents (Humphries, 2003). New technology was put in place, made operational and maintained by a small army of highly skilled men. They were highly skilled clock- and instrument makers, woodworkers, toymakers, glasscutters, and similar specialists, who could accurately produce the parts, using the correct dimensions and materials, who could read blueprints and compute velocities, understood tolerance, resistance, friction, and the interdependence of mechanical parts. These anonymous but capable workers were an essential complement to inventors and engineers. They turned models and designs into working machinery, operated and repaired it, and produced a cumulative torrent of small, incremental, but cumulatively indispensable microinventions, without which Britain would not have become the "workshop of the world." They comprised perhaps five to ten percent of the labor force.

Most of the skills that the workers' elite of skilled craftsmen brought to the factories were the culmination of a century-long accumulation of expertise in traditional crafts. If the rise of new technology, and the high complementarity of their skills with the adoption of more productive

²³The authors argue that their indicator of human capital accumulation is a good predictor of subsequent growth. Baten and Van Zanden 2006.

machinery, made their human capital more valuable, we should find changes in the wage premium for this group. In other words, the collapsing wages of handloom weavers might have been compensated by the growing demand for the highly skilled craftsmen that erected the new spinning and weaving machinery in Lancashire. While evidence is fragmentary, there is some indication that employers scrambled to find glass-cutters, millwrights or fine mechanics (Musson and Robinson 1960). One conceptually appealing test of human-capital based models of the Industrial Revolution would focus on movements in the pay rate of this labor aristocracy, compared to the rest, and on the supply response that these differences in pay engendered. The failure of traditionally measured skill premia to show a rise may well mask an increasing polarization within the workforce, with industrialization raising the returns to supervisory and advanced mechanical skills, and reducing those for standard ones (such as blacksmithing, carpentry, and weaving).

We may have to widen our definition of the relevant human capital yet further. The rise of the factory system required general skills that were not necessarily transmitted through formal schooling – discipline, punctuality, and respect, in addition to literacy and numeracy. Recent work in labor economics has highlighted the importance of non-cognitive skills (Heckmann and Rubinstein 2001). The equipment and materials used by workers belonged to the capitalist and were costly. Factory owners needed to install into workers a culture of loyalty, and sobriety, a willingness to take instructions from and cooperate with other workers. This is a direct result of the expensive equipment in factories.²⁴ Beyond that, the more complex technology and finer division of labor created interdependencies between workers that required coordination between them that would have been hard to enforce unless workers were willing and cooperative. Wage premia for *disciplined* work in the factories were high vis-à-vis other, more self-determined forms of employment, and the factory system’s profitability relied crucially on work intensity (Pollard, 1965; Clark 1994). Steep experience-based earnings profiles in the textile industry offered high returns to those who could stand the habituation to factory work. During their early years, when unskilled workers such as brickmakers were better paid, skilled workers were effectively investing in their own human capital; by age 35, they could look forward to earning 2.3 times the wages of a brickmaker, and more than a coal miner (Boot 1995).²⁵

For similar reasons, monitoring workers was a highly important task. If “discipline capital” mattered more for the first Industrial Revolution than education as conventionally measured, economic historians should compile more comprehensive wage measures that capture the rewards for workers who successfully internalized the demands of the machine age. Also, if the returns to disciplining workers were large, we should find high and rising pay premia for

²⁴ This insight is hardly indebted to modern theory: Karl Marx, in a famous passage, cites an industrialist telling the economist Nassau Senior that “if a labourer lays down his spade, he renders useless, for that period, a capital worth 18 pence. When one of our people leaves the mill, he renders useless a capital that has cost £100,000” Marx (1967, Vol. I, pp. 405–06).

²⁵ Coal miners are arguably a better standard of comparison, since the wage of textile operatives will also reflect differences in the harshness of working conditions – and since those in coal mines were probably worse than in textile factories, skill accumulation is a good explanation.

outstanding foremen and other members of the evolving hierarchies that ensured the smooth running of 19th century factories. The most obvious testable implication of this idea that early factory owners should have a preference for the employment of comparatively more pliable workers, even if they were of low skill — i.e., women and children. This was very much the case in the early stages of the textile mills. Similarly, one valid test of the human-capital approach would focus on highly skilled workers such as the textile operatives examined by Boot and Leunig, and to ask whether they did receive greater rewards for investing in their skills (by accepting years of poorly paid on-the-job training) than, say, apprentices in traditional sectors?

These observations suggest that non-cognitive skills and informal education may have mattered more in explaining the transition to self-sustaining growth in Europe than formal schooling and traditional reading and writing skills. In this sense, distinctions between education and human capital on the one hand, and culture on the other become increasingly artificial. Since Max Weber's work on the spirit of capitalism, culture is one of the "usual suspects" that may determine wealth and productivity, and modern scholars (e.g. E.L. Jones, 2006, pp. 126-132; Temin 1997) have concurred. There is now increasing evidence that its impact can be demonstrated in modern-day data. This suggests that economic historians may want to revisit the issue. Guiso, Sapienza, and Zingales (2006) show an exogenous effect from culture to income and that culture has a lot of persistence (see also Tabellini, 2006). Here, culture is defined above all in terms of the values and beliefs of individuals. While trying to control as much as possible for endogeneity, these studies still show that when people trust one another, believe that if they work hard they will get ahead in the world, and that on the whole the formal institutions of power in the country are not threatening them, economic progress will ensue. We have no record, of course, of such poll-based data for historical times, and so there is no easy way that such findings can be reproduced. But the importance of private-order institutions, that is, the kind of arrangements that made people keep their promises and behave in an honorable way because they had realized that opportunistic behavior was not a dominant strategy in view of the reputational damage that such behavior would entail, seems quite striking. In this interpretation, the middle classes of commercial societies adopted a more cooperative mode of behavior, leading to Pareto improvements. The focal point in such equilibria may well have been what middle class people perceived as "gentlemanly behavioral codes," which is to signal that one belonged to or wished to belong to a class that was sufficiently disinterested in money that one would not cheat a partner (Mokyr, 2007). It may well be that such social norms were far more important than third-party enforcement of laws and contracts in the support of European markets, especially credit and labor markets.

But whence such middle class values? In an innovative paper, Doepke and Zilibotti (2007) offer a less sanguine view of gentlemanly behavior. They offer a model of class formation through endogenous, inheritable preferences. They argue that the rise of a bourgeois elite in industrializing Britain may be regarded as a surprise. Before the transformation got under way, aristocrats had all the odds stacked in their favor – available funds, political connections, access to education. Yet few members of the old political elite actually got rich in manufacturing after 1750. Doepke and Zilibotti argue that this is because other groups of society – the middle classes

– had accumulated a larger stock of “patience capital”, that is, a host of cultural practices and norms that make the delay of immediate gratification accepted and expected. The intuition here is that artisans need to defer gratification because it takes a long time to accumulate human capital (that is, to complete the training needed to become a craftsman). On the other hand, the old aristocracy taught their children how to enjoy leisure and thus provided them with a culture that worked against both hard work and investment. Through centuries of careful saving and educating their young, the middle class built up both financial capital and valuable cultural traits. As the new technologies of the Industrial Revolution suddenly offered greater returns to patience, the groups best-placed to exploit them were not the elite but those with steep earning profiles, that is to say, those who would do well in mid-life if they invested in themselves as lads. Those people had to acquire patience capital, and it is this kind of culture that played a central role in the subsequent development of capitalist industrialism. In this account, the *absence* of well-functioning credit markets is a key element in the story – only when financial markets are segmented do returns to patience (adjusted for risk) differ across groups. They apply their model to the decline of the aristocracy in Britain, generating an impressive fit overall between their predictions and historical fact.

The concept of patience capital arguably holds even greater promise. It may be no accident that the “nation of shopkeepers”, as Adam Smith called it, became the first to industrialize. It offered an environment in which bourgeois values and practices flourished and gained in relative importance. If Europe saw a rise of bourgeois values prior to the Industrial Revolution, it was complemented by a rise in work intensity and the length of the working day for the lower classes, and the growing orientation on the market at the expense of self-sufficiency. DeVries (1994) termed this change the “industrious revolution”. By the eighteenth century, even Catholic rulers were abolishing holy days to boost labor input in their economies. Clark (1987) found evidence that work intensity in the most economically advanced parts of Europe was much higher than elsewhere. Voth (1998, 2001) argues that the work-year in Britain was already long in 1750, and that it lengthened further because of a decline in festivals, holy days, and the practice of taking Mondays off (“St. Monday”). Such changes are consistent with the model proposed by Doepke and Zilibotti, in which those with relatively low “leisure skills” became the dominant classes.

Culture may be subject to evolutionary forces (e.g., Boyd and Richerson, 1985). Galor and Moav (2004) offer a model in which the crucial state variable that changes during the pre-industrial period is not just population size, but “human quality” (genetic or behavioral). Households endowed with more desirable human characteristics (education, the right genes, economically beneficial attitudes) produce more surviving offspring and gradually but ineluctably change the composition of the population. Therefore, the quality of the human population drifted up prior to the Industrial Revolution. But disentangling “inherent quality” from changes resulting from responses to changing incentives seems a formidable challenge. Also, natural selection, as biologists have long realized, normally need not increase quality at all; it simply is adaptive to existing circumstances but utterly myopic, so that it is easy to see why it may not result in any secular improvements.

Given that humans normally only start to reproduce in their late teens or early twenties, any process that relies on natural selection requires a very long time-span – or strongly divergent fertility rates.²⁶ The Galor-Moav approach has recently received some qualified empirical support. Clark and Hamilton (2006) found that the rich and literate in early modern England fathered more surviving children. Whether natural selection improved in some definable dimension the quality of the population in the countries about to break out of the Malthusian model before the 1700's is still far from an established fact. However, Clark's and Hamilton's result that wealthier Englishmen had more surviving children could suggest that, instead of leading to an upward drift in some unmeasured, unnamed indicator of human quality, it simply enlarged the relative size of those who had learned to save (and invest), and those who passed such values on to their offspring. Such a change in population composition would also have contributed to the decline in English interest rates since the Middle Ages (Clark 1988), from 10-11 percent in the 13th century to 4 percent by the 18th. A gradual increase in savings, caused by compositional effects attained through the increase in the relative number of those who were more patient, would be an alternative to the theories that attribute the rise in savings to the "Calvinist ethic." The tendency of interest rates to decline in stable and prosperous countries, as noted by Adam Smith in the case of Holland, may not necessarily indicate that technology was stagnant and returns to capital diminishing rapidly. It may simply be that patience (and financial intermediation) was growing faster than savings could be channeled usefully into investments.

Compositional change may also help us understand evolving demographic behavior. Fertility rates and age at first marriage often differs across subgroups, as both historians and economists have found.²⁷ Given that European living standards far exceeded subsistence levels during the early modern period, many more children could have been born. Constraints on fertility behavior were mostly social and cultural (working through nuptiality rates). It is therefore easy to see how evolving norms could have changed population growth rates. Differential fertility behavior and evolutionary mechanisms might thus help us explain how and why the Malthusian regime came to an end. In the Galor and Moav (2002) model, for example, this is depicted as the gradual increase of the number of people with a strong preference for "high-quality offspring." As yet, we know far too little about the relative differences in reproductive behavior (as manifested, for example in different marriage ages) and economic success in early modern Europe. Compositional change may have played a large role, but at the current stage, it is hard to tell. What is needed is more evidence along the lines of the material gathered by Clark and Hamilton documenting differential fertility and survival over the long run.

²⁶Given that the earliest data are from the 16th century, there were only approximately 5-6 generations over which we can be reasonably certain that this selection effect might have worked – not a great length given the modest reproductive advantage. All the same, recent genetic research has suggested that "evolutionary changes in the genome could explain cultural traits that last over many generations as societies adapted to different pressures" (*New York Times*, March 7 and March 12, 2006).

²⁷In addition to Clark and Hamilton (2006) cited above, we may mention the work by Herlihy (1997, pp. 56-57) and Galor and Moav (2002).

4. Technology

Whatever else, technological change has remained the backbone of modern economic growth simply because all other potential sources of productivity growth such as capital accumulation, improved allocations and gains from trade thanks to better institutions, and economies of scale of one sort or another all tend to run into diminishing returns at some level. One organizing concept that has proven hard to model formally but without which no historically accurate picture of modern growth can be formed is the connection between science and technology in the Industrial Revolution and beyond. Historical scholarship has bifurcated here into a minority view, which continues to view science and scientific culture as crucial to the Industrial Revolution (Musson and Robinson, 1969; Rostow, 1975; Jacob, 1997; Lipsey et al., 2005), and a majority, which has dismissed the role of science as epiphenomenal and marginal (Landes, 1969; Mathias, 1979; Hall, 1974; Gillispie, 1980). Examples of the importance of science and mathematics to some of the inventions of the Industrial Revolution can certainly be amassed. It is equally true, however, that many of the most prominent breakthroughs in manufacturing, especially in the mechanical processing of textiles, were not based on much more science than Archimedes knew, and that in other areas of progress, such as steam power, pottery, and animal breeding, progress occurred primarily on the basis of trial and error, not a deep understanding of the underlying physical and biological processes.

The debate between those who feel that science played a pivotal role in the Industrial Revolution and their opponents is more than just a dispute whether a glass is half full or half empty, because the glass started from almost empty and slowly filled in the century and half after 1750. Scientists and science (not quite the same thing) had a few spectacular successes in developing new production techniques, above all the chlorine bleaching technique, and the inventions made by such natural philosophers as Franklin, Priestley, Davy, and Rumford. While the Industrial Revolution in its classical form might well have occurred, with a few exceptions, without much progress in science, it is hard to argue that it would have transformed into a continent-wide process of growth without a growing body of useful knowledge on which inventors and technicians could draw. It is not possible to “date” the time at which this kind of collaboration began. In some areas it can already be discerned in the mid eighteenth century. It is equally clear, however, that in crucial “new” areas of technology in the post 1820 years, scientific knowledge became increasingly important to the development of new technology. Two of the most remarkable developments of the era, the telegraph and the growing understanding of fatty acids in chemicals took place in the final decades of the classical Industrial Revolution. Trial and error, serendipity, and sheer intuition never quite disappeared from the scene, but improved knowledge about how and why a technique works made it far easier to refine and debug a new technique quickly, adapt it to other uses, and design variations and recombinations that would not have occurred otherwise. In chemicals, steel, electricity, food processing, power engineering, agriculture, and shipbuilding technology, to name but a few, the ties between formally educated people who tried to understand the natural phenomena and regularities they observed, and the people whose livelihood depended on putting such insights to good use became tighter and closer after 1750, and continued to do so (Mokyr, 2002).

The underlying institutions that made this growing collaboration possible have been investigated at length. Although intellectual property rights were of some importance, they cannot possibly explain the entire process. Jones (2001) is the only growth paper to date that models time-varying institutional parameters directly, and it turns out to play a pivotal role in his model in whether the Industrial Revolution was “inevitable.”²⁸ Jones’s parameter π_t , which is the proportion of total consumption allocated to people employed in the ideas-generating sector is computed to match the data, but displays a bizarre history (Jones, 2001, p. 24), actually falling from .44 percent to zero between the sixteenth and the eighteenth century, rising sharply in the eighteenth century, then falling to half that value in the nineteenth century, before leaping by a factor of 12 to 5 percent in the twentieth century. Yet nothing in his model allows for the complex motivation that propelled the ideas-sector in earlier history, in which many natural philosophers and inventors were as much interested in signaling as in financial gains, much like a modern open-source technology (Lerner and Tirole, 2004). Models that purport to explain the growth of technology in this age must recognize the different ways of assigning property rights in the two separate segments of the “ideas-sector.” Whereas prescriptive knowledge, that is, techniques, could be patented and thus be allocated at least some form of property-rights, this was never done with propositional knowledge in which priority credit assigned to the owner did not include exclusionary rights. Yet it is hard to understand the growth of technology during the Industrial Revolution and after without explicitly recognizing the feedback between these two forms of knowledge (Mokyr, 2002; see also David and Dasgupta, 1994). Scientists in pre-1850 period were rarely interested in reaping the material gains that their finding could generate, insisting on credit rather than profit. As “gentlemen-philosophers” they refused to make a living from their discoveries and were suspicious of anyone who did (Bowler and Morus, 2005, pp. 320-21).

It is also worth noting that a recent attempt to estimate the value of inventions accruing to the inventors for modern America has found that only about 2.2 percent of the value of an innovation is captured by the inventor him- or herself (Nordhaus, 2004). Whether the number was higher during the Industrial Revolution seems unlikely. The patent system is central to this story, but its effect on the process of technological progress during the Industrial Revolution is still very much in dispute. The operation of the patent system awarded monopolies to inventors, yet infringements and other failures of the system implied that first-mover advantages and old-fashioned government and private-sector prizes were as important as the rents earned by inventors.²⁹ The British patent system was far from user-friendly: it was costly to file a patent, and often hard to defend patents against infringers (Khan and Sokoloff, 1998; Dutton, 1984). The patent laws were widely condemned as ineffective in protecting the vast majority of inventors, and did so at a high cost (McLeod and Nuvolari, 2007). Most inventions, even the most successful ones, were not patented (Moser, 2005). The fact that Britain’s system was thus less

²⁸This parameter π in Jones’s model defines the proportion of total income that accrues to those who are employed in the “ideas-sector” and in equilibrium equals the fraction of labor in the economy allocated to producing new ideas.

²⁹The literature on the operation of the patent system in Britain is quite large, for an introduction see Dutton (1984), MacLeod (1988) and MacLeod and Nuvolari (2007).

likely to encourage potential inventors than the corresponding U.S. system does not seem to have affected British technological leadership before 1850. Charles Babbage, never one to mince words, denounced the patent law as a “a fraudulent lottery which gives its blanks to genius and its prizes to knaves” (1830, pp. 333, 321). The best we can say about the patent system is that it provided an *ex ante* belief that successful invention *could* pay off to a few lucky people, and thus provided a positive incentive.

Instead a deeper and more encompassing social phenomenon was at play here, namely growing flows of information and improving interaction between people who made things (entrepreneurs and engineers) and people who knew things (natural philosophers). Not only that this interaction meant that what useful knowledge had to offer was accessible to those who could make best use of it, it also meant that the agenda of science was increasingly biased toward the practical needs of the economy. The bridges between *savants* and *fabricants* took many forms, from written technical manuals and treatises, to academies and scientific societies, where they rubbed shoulders and exchanged ideas. By the closing decades of the eighteenth century it was normal for scientists to consult to manufacturers and farmers, looking for improved bleaches, more efficient engines, or improved fertilizers.

By 1815, the need for this kind of collaboration had become a consensus, and the European economies competed with one another in encouraging it. In Britain, the Society of Arts, established in 1764, the Royal Institution, founded in 1799, and the Mechanics Institutes (first established by George Birkbeck in 1804) were examples of how private initiatives could carry out this task in the land where people believed above all in private initiatives. Less formal institutions abounded, the most famous of all being the Birmingham Lunar Society, which brought together the top scientists with some of the most prominent entrepreneurs and engineers. Less well known but equally significant were the Spitalfields Mathematical Society, founded in 1717, and the London Chapter Coffee House, the favorite of the fellows of the Royal Society in the 1780s, where learned men discussed at great length the mundane issues of steam and chemistry (Levere and Turner, 2002). In France, Germany, and the Low Countries, government took a more active role in bringing this about (e.g., Lenoir, 1998). Not all of those efforts were unqualified successes: the engineers of the Paris *École Polytechnique* were often too abstract and formal in their research to yield immediate results. In Germany, the University system was on the whole rather conservative and resisted the practical applications that governments expected of them. New and more effective institutions were established, however, and the old ones eventually reformed.³⁰ The decades after 1815, then, were the ultimate triumph of the Baconian vision, that had formed the basis for the founding of the Royal Society in 1660. To achieve this triumph, Europe had to undergo changes in its institutional set-up of the accumulation and dissemination of useful knowledge, yet these institutions were based on the scaffolds (to use North’s term) of an Enlightenment ideology that firmly believed in material progress and advocated concrete programs as to how to bring it about.

³⁰In Germany, universities had increasingly to compete with the technical colleges or *Technische Hochschule*, the first of which was set up in Karlsruhe in 1825. In France new *grandes écoles* were set up to provide more practical education such as the *arts et métiers* in 1804,

Modeling the production of “new ideas” is of course one of the hardest things to do in growth models, and endogenous growth models have had to simplify away much of its historical richness. Thus the literature has not dealt effectively with the high riskiness of the inventive process, in which investing in the “ideas-producing” sector is more akin to purchasing a lottery ticket than to choosing an occupation.³¹ While some models refer explicitly to “the number of ideas produced,” such a concept is of course highly problematic, not only because ideas fail to meet the rules of arithmetic, but also because so many ideas generated were simply dead-ends, mistakes, or even pure fantasy. On the other hand, much of the new technology was the result of minor but cumulative improvements resulting from the experience and learning-by-doing of skilled craftsmen rather than some kind of cognitive flash. While such artisanal advances were not all there was to technological change during the Industrial Revolution, their importance has been rightfully stressed by recent historians (Berg, 2007).

5. Conclusion: Progress out of Misunderstandings

Theorists and economic historians interested in the transition to self-sustaining growth often appear as distinct tribes, separated by a common object of study. This has hampered progress in understanding how the switch from “Malthus to Solow” occurred. We highlight a few particular sources of misunderstanding, and offer suggestions for future research that should do much to reconcile the tribes and augment intellectual gains from trade.

Economic theorists writing on long-run growth often apply their models to industrializing Britain, the classic, first case of an Industrial Revolution. This forces them to ignore or to play inconvenient facts about the economic history “*wie sie wirklich gewesen ist.*” Jones (2001), for example, produces a model in which working hours have to fall during the transition, while they probably actually rose. Lucas and Becker et al. emphasize the increasing demand for and returns to human capital, when we find little evidence of this. Acemoglu et al. underline the importance of constraints on the executive in early modern Europe, when it is far from clear that the groups producing serious restraints had anything to offer for growth. The list could be extended, but it is merely meant to be illustrative.

Economic historians have been quick to point out the most glaring contradictions, pointing out that the “Industrial Revolution in most growth models shares few similarities with the economic events unfolding in England in the 18th century” (Voth 2003). We believe that the discussion should not stop here. The logic of many unified growth models makes them less than well-suited as an explanatory toolkit for the classic British Industrial Revolution, despite the tendency of growth theorists to apply their models to that case (Galor 2005; Hansen and Prescott 2002;

³¹Indeed, this aspect of technological progress may well be better analyzed by behavioral economists and decision theorists who deal with models in which people systematically overestimate their own chances at succeeding. This was already understood by Adam Smith who noted “Their absurd presumption of their own good fortune is ... still more universal [than people’s overestimating their own abilities]... the chance of gain is by every man more or less over-valued, and the chance of loss...undervalued” (Smith [1776], 1996, p. 120).

Lucas, 2002). Conversely, economic historians have been too narrow in their criticisms. Once we lengthen the period during which demographic changes are analysed, examine human capital accumulation over the very long run, and broaden the relevant set of skills beyond literacy, as traditionally emphasized, many of the apparent contradictions are diminished. The Malthusian regime probably gradually broke down during the years 1500-1800, and many relevant changes in human capital probably began after the Reformation. In the same vein, once economic historians and theorists focus more on non-cognitive skills and cultural features such as patience, prudence, and discipline, it will be easier to build models that are broadly consistent with the historical record. In this light, unified growth theories have substantial explanatory power – especially those that emphasize a transition to modern growth in two phases, with Malthusian constraints declining first, and human capital becoming more important later. What seems at this time still unexplained is the long lag structure — why would it take not decades but centuries before the underlying processes transformed themselves into sustained economic development.

The time period under consideration is not the only important source of misunderstanding. As Rickert and Windelband emphasized, history is ‘ideographic’ – seeking to explain what is unique. Theorists are, of necessity, ‘nomothetic’ – in search of covering laws. While the discussion of the British Industrial Revolution in, for example, Hansen and Prescott (2002) is meant as an illustration of a model that could apply to Europe (or, indeed, the world as a whole), historians have often focused on the empirical accuracy in individual cases. Equally problematic is the tendency to examine the logic of historical papers from a cross-sectional perspective. Economic historians have rarely resisted the temptation to demand predictive power for our own time’s distribution of economic development from models for the crucial question of explaining “why Britain came first”, and not France or China (Crafts 1998, Broadberry 2007). The models in Kremer (1991) and Galor and Weil (2000) refer to the world as a whole. Nonetheless, economic historians have criticized endogenous growth models because they fail to offer convincing explanations for divergence between countries. This is clearly a case of hunting rhino with sharpened kiwis.

However, and by the same token, theorists have not given much attention to the important implications of cross-sectional differences in the timing of growth spurts.³² For example, Hall and Jones (1998) document large differences in output per capita between rich and poor countries. They conclude that neither capital nor human capital can explain these differences; TFP and “social capacity” must be responsible. The underlying models only make sense if we assume that economies have reached their steady state, or that they should have the means to converge to it rapidly. Most papers in the growth literature using the Summers-Heston dataset share this assumption. However, one of the most striking empirical observations about growth during the last 200 years is that “take-off” into self-sustaining growth has occurred at different points in time and that the differences in timing have proven very hard to explain. Some sad reversals (such as Argentina) apart, differences in the starting point of economic growth will lead

³² One recent exception is Voigtlaender and Voth (2006), who offer a model designed to explain part of the “Great Divergence” between Europe and China.

to an inverse U-shaped pattern of productivity differences over time. Relaxing the assumption that economies are in steady state, and focusing on what allows economies to enter the phase of rapid, self-sustaining growth, resolves many of the apparent puzzles in the current growth literature (Ngai 2003). Relatively small inefficiencies can suffice to produce large differences in output per head if they *delay* the onset of modern growth. What is needed, then, is a set of theories aimed at more explicit dynamics: what was behind phenomena such as timing, lags, and the long historical delays between prior historical changes and the onset of modern growth. This implies that theorists may continue to rely on cross-sectional evidence about divergent growth paths as inspiration for their models, but that economic history offers far greater riches. A closer collaboration between those who want to discern general laws and those who have studied the historical facts and data closely may have a high payoff. Only when we understand which inefficiencies and delaying influences could produce the time pattern of “take-offs” that we observe in the last two centuries can we conclude that our understanding is beginning to be as complete as the term “unified growth” theory suggests.

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